

Indirect cost controversy puts
universities in the hot seat
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CHEMICAL & ENGINEERING

NEWS

Stanford's
Carl Djerassi
wins 1992
Priestley Medal
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News of the Week

■ More U.S. high school students are taking math and science courses following recent efforts by states to strengthen requirements for such courses. **Page 4**

■ Spacecraft Magellan completes first cycle of radar mapping of Venus, providing scientists with impressively detailed pictures of the planet. **Page 5**

■ President Bush outlines proposal to rid Mideast of weapons of mass destruction and to stem buildup of conventional weapons. **Page 5**

■ Recent Congressional approval of "fast-track" approach to trade negotiations is good news for U.S. chemical industry. **Page 6**

■ National Institutes of Health seeks coinventor status for AIDS drug AZT, will support Barr Laboratories in its bid to market generic form of the drug. **Page 6**

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Published estimates of toxic chemical emissions by industry provide occasion for environmentalists to complain about how seriously the environment continues to be contaminated. **Page 20**

Science/Technology

Opportunities and challenges for catalytic chemistry are stressed in National Research Council report previewed at recent Catalysis Society meeting. **Page 23**

New insights into behavior of monolayers on surfaces are provided by scanning tunneling microscopy. **Page 26**

Discovery of novel bimetallic yttrium-copper complex may lead to easier fabrication of some superconductor materials. **Page 27**

Books

"Technological Risk" by H. W. Lewis offers reader-friendly assessment of the broad subject, but falls down in its discussion of political players involved. **Page 32**



Priestley Medal

Carl Djerassi, a chemistry professor at Stanford University, will receive ACS's 1992 Priestley Medal in recognition of his contributions to chemistry and society. **Page 28**

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LETTERS

Fruitful collaboration

Rudy Baum's article highlighting a Division of Medicinal Chemistry symposium at the ACS Atlanta meeting on the mode of action of anticancer drugs (C&EN, May 6, page 31) failed to cite an important point mentioned in my presentation. The long and fruitful collaboration between JoAnne Stubbe of the department of chemistry at Massachusetts Institute of Technology and me has been an essential component in our mechanistic unraveling of the action of bleomycin on DNA. As most researchers in the field are well aware, our decade-long interaction on this problem has been a most productive one as evidenced by our joint publications on this and related topics.

Since I did not have the opportunity to review the article before publication, I hope this letter will set the record straight and permit Stubbe, me, and our research groups to share the generous recognition in Baum's article.

John W. Kozarich

Professor of Chemistry and Biochemistry
University of Maryland, College Park

Fast-track trade agreement

The U.S. chemical industry applauds Congress for recently extending President Bush's "fast-track" trade agreement negotiating authority beyond June 1, 1991. That action—which culminated an intense legislative debate—lays the groundwork for continuing two very important international trade negotiations that could have a long-term, positive effect on the chemical industry.

Essential for trade negotiations, fast-track allows the President to negotiate bilateral or multilateral trade agreements with the understanding that Congress has only two options as concerns the negotiated terms. Congress can either approve or disapprove the trade agreement in its entirety. The agreement cannot be picked apart. Without it, other countries would not spend years negotiating a treaty with the U.S., knowing that the individual terms would later be amended by Congress.

Now that Congress has extended fast-track authority, trade negotiations can proceed on both sides of the Atlantic. A successful Uruguay round of the General Agreement on Tariffs & Trade (GATT) under negotiation in Geneva could expand the access of U.S. companies to markets around the world. The chemical industry will be working with the GATT negotiators to provide increased market

access for chemical exports, increased global protection for our intellectual property, and fair treatment of our growing foreign investments.

Fast-track extension also opens the way to begin negotiations on a North American Free Trade Agreement (NAFTA) that will bind the U.S., Mexico, and Canada into a trade union larger than the European Community. NAFTA will have a buoyant effect on the economies of all three nations. In particular, it will accelerate Mexico's growth into a market-oriented economy that will create growth markets for our chemical exports as well as new investment opportunities for our companies.

The U.S. chemical industry strongly believes that if NAFTA is successfully negotiated, it could be very beneficial to all parties. From a chemical industry perspective, we are encouraging our trade negotiators to seek phased elimination of bilateral tariffs, greater foreign participation in Mexico's petrochemical industry, guaranteed intellectual property protection, and removal or reduction of export subsidies. The industry also supports the negotiation of a parallel agreement that would elevate Mexico's environmental compliance enforcement to a par with that of Canada and the U.S.

A successful NAFTA will create an attractive investment environment in Mexico. Industry that might have been established in Southeast Asia today, would more likely be situated in Mexico tomorrow—if NAFTA becomes a reality. The resulting economic growth would stimulate Mexico's purchase of additional U.S. products and services. Already, 70% of Mexico's imports of goods and services originates from the U.S. Without NAFTA, more of the new plants would be built in Asia. The host countries and Japan would benefit, not Mexico and the U.S.

For the chemical industry, a free trade agreement that includes Mexico will be a positive step as we continue to meet the challenge of international competition. It will help Mexico develop into a modern market-oriented economy. It will give U.S. chemical exports clearer access to that growing economy. And it will greatly increase the size of what we call our home market, allowing us to build larger, more economical, and more efficient plants both in the U.S. and in Mexico. However, the extension of fast-track only gets us to the negotiating table, where the work will really begin. The chemical industry will have to actively participate in the NAFTA negotiations through our private-sector advisers and trade groups. If we are successful in

Use of Specialty Food Additives To Continue To Grow

Convenience foods, health concerns are driving growth in demand for chemicals and materials used as food additives, replacements

Ann M. Thayer,
C&EN Northeast News Bureau

Few processed foods can be found that do not contain one or more of the thousands of different chemicals and materials that are food additives. According to recent estimates, about \$5.5 billion worth of additives are used widely in the \$385 billion U.S. food and beverage market. Throughout the 1990s, the U.S. market for food additives is expected to grow 4 to 6% annually—to as much as \$7 billion by 1995.

The development and use of food additives is frequently driven by consumer demand and often becomes a balancing act between consumers' seemingly contradictory desires—the desire for more "natural" foods versus that for prepared, often microwaveable, convenience foods. The situation is complicated further by the desire for low-calorie, low-fat, and low-cholesterol foods.

Health concerns and the desire for convenience foods will drive market growth for food additives, particularly for new products such as high-intensity sweeteners and fat replacers. The impact of these trends on markets and developments in food chemicals was the focus of a session sponsored by the Division of Chemical Marketing & Economics at the recent ACS national meeting in Atlanta.

Companies involved in the production of specialty chemicals as food additives have been estimated

to number in the hundreds, ranging in size from large chemical manufacturers such as Dow, Monsanto, W. R. Grace, and Hercules, to small specialty flavor or color producers.

But only a few hundred food additives account for more than 90% of market volume, says Newman H. Giragosian, president of Delphi Marketing Services in New York City. And, according to the consulting firm SRI International, fewer than 10 chemicals have a market value over \$40 million. Only aspartame is sold in any appreciable volume (more than 5 million lb) at a price above \$20 per lb. Since food additives are used in small amounts, most are sold in small volumes, are priced on a performance basis, and fall into niche markets.

The fragmented market is viewed most easily from either an additive's function or its end use. Additives in foods act as sweeteners, flavors, colors, thickeners, emulsifiers, acidulants, antioxidants, nutrients, and preservatives. Processed food markets using additives vary from soft drinks to alcoholic beverages and from meats, poultry, seafood, and dairy products to baked goods.

As the demand for prepared or processed foods increases, so too will the demand for food additives, says Giragosian. But the industry faces problems, he explains, such as increased "consumerism" based on greater knowledge about additives, which can result in negative publicity and negative connotations for additives, and a movement toward "natural" foods. Coupled with increased government regulation, high R&D and regulatory approval costs, and longer times to reach commercialization, he adds, these factors can negatively affect growth.

Because of the nature and dynamics of the industry, these factors

won't affect all categories of food additives equally. Opportunities exist for new materials considered healthier or those that replace additives that are suspected health hazards. Mature markets with limited differences between competing products such as vitamins, thickeners, emulsifiers, antioxidants, and preservatives are not expected to show so much growth as is expected for nonnutritive sweeteners, fat substitutes, and flavoring agents.

Although dominated for several years by aspartame (*N*-L- α -aspartyl-L-phenylalanine 1-methyl ester), the sweetener market is expected to continue to grow, some estimate by as much as twice the rate for the overall market for food additives. A significant event will be the expiration of NutraSweet Co.'s U.S. patent on aspartame in mid-December 1992. NutraSweet, a wholly owned subsidiary of Monsanto, has about 98% of the dollar value of U.S. sales for sweeteners, according to a 1990 study by the consulting firm Frost & Sullivan. This is expected to drop below 50% as other products are approved by the Food & Drug Administration.

Stability, taste, and safety are primary competitive factors. Improvements in these areas will allow sweeteners to find use in an even wider range of food types. Better heat stability would offer a sizable advantage and reduce demand for saccharin which, although it can be used in cooking and baked goods, has had limited use because of its unpleasant aftertaste. Liquids make up about 70% of the sweetener market and dry foods the remaining 30%.

Although the expiration of NutraSweet's patent may bring down prices, as it has in Europe, new higher intensity sweeteners to compete with aspartame also may be

high priced. However, many sweeteners show a compounded effect when used together, thereby reducing the amount needed. Approved in 1988 and gaining some market share is Hoechst Celanese's acesulfame-K. Other possible near-term products awaiting approval are sucralose, codeveloped by Tate & Lyle and Johnson & Johnson, and alitame, developed by Pfizer.

Acesulfame-K is the potassium salt of 6-methyl-1,2,3-oxathiazin-4(3H)-one 2,2-dioxide, marketed under the tradename Sunette. It is about 200 times sweeter than sucrose, and noncaloric. According to the company, it has a long shelf life and is stable when exposed to heat, the lack of which are considered shortcomings of aspartame. FDA approval is food-type specific, and to date it has been approved for use in dry beverage mixes, chewing gums, desserts, and tabletop uses. Thus it is not yet competing with aspartame in beverages.

Sucralose is a chlorinated sucrose derivative, about 600 times as sweet as sucrose, which does not break down in the body. Like aspartame, alitame (L- α -aspartyl-N-(2,2,4,4-tetramethyl-3-thietanyl)-D-alaninamide) is amino acid based. It is said to be 2000 times sweeter than sucrose and partially metabolized, with a minimal number of calories. In addition to alitame, Pfizer has capacity to produce more than 50 million lb of polydextrose, a low-calorie bulking agent used to replace sugar and some fat.

Along with the desire for low-calorie foods, the demand for low-fat foods is expected to lead to rapid growth in the market for fat substitutes and mimetics. Sales of low-fat and low-cholesterol processed foods are estimated to grow from \$28 billion at the end of 1991 to almost \$33 billion in 1993, says Joanne Kennedy, technical service representative from Stepan Co., a specialty chemicals manufacturer. Figures from the U.S. Department of Agriculture's *National Food Review*, she adds, show there is potential to replace more than 16 bil-

Food additives' sales to grow

\$ Millions	1990*	1995*	Annual change
			1990-95
Sweeteners	\$1000	\$1310	5.5%
Gums/thickeners	854	1100	4.5
Flavors/enhancers	800	785	5.5
Emulsifiers	460	515	2.3
Acidulants	246	287	3.1
Colors	220	272	4.3
Vitamins/nutrients	157	177	2.4
Enzymes	143	169	3.4
Preservatives	83	92	2.1
Antioxidants	24	27	2.4
Fat mimics	na	na	—
Other	500	585	3.2
TOTAL	\$4317	\$5319	4.3%

* Estimated. Source: Delphi Marketing Services

lion lb of fat used in cooking, baking, and frying, or found in dairy items such as cheese, butter, ice cream, and yogurt.

Fat replacement products and technologies are being developed by many firms, she explains. These can roughly be divided into two categories—synthetic fat substitutes and fat mimetics. "Synthetic fat substitutes are nondigested, noncaloric fat replacers that are molecularly like a fat," she says. Substitutes must function similarly to fats, be nontoxic, and have any metabolites completely excreted while not draining the body of vitamins or nutrients.

"This whole area will be slow to develop," says Kennedy, "because of safety questions." Unlike most food additives, fat substitutes could represent up to one third of a person's

daily caloric intake. "Usually, an additive's acceptable consumption level is determined by testing high dosages, 100 times or more than normal. How do you feed a rat that much fat?" she says. To be competitive as one-to-one replacements for fat, they also must be reasonably priced and consistently available.

A synthetic fat substitute developed by Procter & Gamble is Olestra, a sucrose polyester that is noncaloric and also cholesterol-free. With similar properties to edible fats, says Kennedy, Olestra was submitted in 1987 to FDA for approval in replacing up to 35% of the fat in home-use shortenings and oils, and up to 75% of fat in commercial frying applications.

Other synthetic fat substitutes under development, says Kennedy, include DDM, a fatty alcohol ester of malonic and alkyl malonic esters from Frito-Lay; EPG, propylene oxide derivatives from Arco Chemical; and TATCA, tricarballic acid esterified with fatty alcohols from CPC International. Other than through extraction or drying methods, she explains, fat removal or replacement in frying is not now possible since nonnutritive heat-transferring oils are not yet available.

As another category of fat replacers, fat mimetics cover a broad range of materials and mimic the "mouth feel" of fat. Being carbohydrate- or protein-based, they have at most 4 calories per gram, says Kennedy, as compared with nine for fats. They generally differ from fat substitutes by being less expensive and are not used across the board as one-to-one replacements. Instead, they are used at relatively low levels of 10 to 50% to bind water.

Starch-based products form bland gels with fatlike textures. Commercial specialty starches include potato, corn, and tapioca maltodextrins produced by Avebe, GPC, and National Starch & Chemical, respectively. Although these have been used for some time in baked goods, frozen desserts, and dressings, a newer product is Oatrim, a β -glucan amyloextrin. Oatrim was developed by the USDA's Regional Research Laboratories in Peoria, Ill., and has been licensed to Rhône-Poulenc and Con Agra.

Aspartame sweetener is single largest product

\$ Millions	1990 sales*	Function
Aspartame	\$ 750	Sweetener
Vanillin/ ethyl vanillin	160	Flavoring
Citric acid	160	Acidulant
Monosodium glutamate	75	Flavor enhancer
Xanthan gum	50	Thickener
Sorbates	55	Preservative
Carrageenan	45	Thickener
Caramel	40	Colorant
TOTAL	\$1335	

* Estimated. Source: SRI International

Microparticulated materials can also mimic fats, but tend to be more expensive, says Kennedy. Simplese, made by a subsidiary of Monsanto, was approved in early 1990. It is egg and milk proteins, heated and sheared to form spheres 0.1 to 2 μm in size. Protein particles this small are perceived by the tongue as feeling creamy. Initially, the company developed its own Simplese-based food product and entered the superpremium ice cream market.

According to the company, its frozen dessert products have a 19% share overall in the superpremium category and hold the leading market share, 34%, of fat-free brands in 70% of the U.S. in which the product was launched. By targeting only the fat-free market at first, says a company representative, Simplese could be introduced in a product labeled as natural. Recently, a fat-free and sugar-free frozen dessert containing Simplese and NutraSweet was launched.

Monsanto is looking for FDA approval to expand Simplese into other areas such as salad dressing, cheese, yogurt, mayonnaise, and margarine. Although it can now be formulated to avoid breaking down at high temperature and used in baked goods or melted cheeses, says Kennedy, it cannot be used like a cooking oil to transmit heat. Kraft is reported to have a protein-based product similar to Simplese, called Trailblazer, currently before FDA for review.

Less expensive water-soluble carbohydrate gums and other materials can bind water and replace fat. These include guar, xanthan, and locust bean gums; pectin; and carboxymethylcellulose. FMC has a product called Avicel that is a microcrystalline cellulose gel. The firm has worked with food processors to use it in low- or no-fat ice creams, salad dressings, bakery products, and cheeses. Another product, by Alpha-Beta Technology and not yet approved, is a microspherical β -glucan fiber derived from yeast.

One of the best known thickeners is carrageenan, a seaweed-derived hydrocolloid. FMC's Marine Colloids business group is a major producer of carrageenan, which is used to thicken, gel, and stabilize foods.

Soft-drinks market uses most additives

\$ Millions	Sales			Annual change 1989-94
	1982	1989	1994	
Soft drinks	\$ 205	\$ 728	\$1170	10.0%
Sauces, dressings, oils	272	432	675	9.3
Meat, poultry, seafood	211	330	455	6.6
Dairy products	187	285	415	7.8
Baked goods	159	273	395	7.7
Processed, frozen foods	82	148	220	8.3
Grain mill products	68	108	150	6.8
Alcoholic beverages	34	53	70	5.7
Other	123	206	350	11.2
TOTAL	\$1341	\$2563	\$3900	8.8%

Source: Freedonia Group

Hercules is also a producer. McDonald's uses carrageenan in its new lean hamburger formulation to hold the meat together and retain moisture through cooking. Carrageenan or starch formulations also are used in poultry products, hot dogs, sausages, and dairy products.

Fat replacers are a good example of how the use of additives in food necessitates the development of flavor additives. Although fat substitutes or mimetics may give the look and feel of fat, they usually do not carry or add the flavors that might develop from cooking or browning. Similarly, sugar not only is part of fermentation in beverages and breads but it also adds bulk, texture, and flavor that may be lacking with nonnutritive sweeteners.

"The flavor industry can look forward to continued growth," says Don Birtwistle, president, McCormick & Wild, a food flavorings joint venture. "Basically, any factor that increases the need for processing or the designing of foods to meet specific needs is likely to call upon flavors to build in consumer appeal for the product." Growth is expected as a result of the need for flavor stability and retention through the freezing and thawing of processed prepared foods, especially those packaged for microwaving.

Another factor in this growth has been an increased demand for natural flavors, he adds. The market for natural fruit flavors is expected to grow at 7 to 8%, whereas artificial flavors will grow at 2 to 3%. Artificial flavors tend to be more powerful and lower in cost than natural

equivalents and thus natural flavors can have a difficult time competing with synthetic versions. However, new technologies are providing the means to produce highly concentrated natural flavors, says Birtwistle, and the higher cost is seen as well worth the increased consumer appeal of a natural product.

Flavor additives can be roughly divided into two categories, explains Birtwistle. One class is flavorings consisting of raw materials or natural products used as the source of flavor. Examples are mint oils and vanilla. A second class is compound flavors that often are mixtures of key synthetic chemicals used to achieve a particular flavor profile. These are designed by deciphering flavor components to reproduce standard or familiar flavors.

The compound flavor market is estimated at \$600 million for 1990, says Birtwistle, and is expected to grow at a rate of 6 to 8% per year. Sales are almost equally divided between fruit flavors, \$330 million, and other flavors, \$270 million, which include dairy, vegetable, meat, poultry, fish, and sweet flavors. The market can also be divided between natural, 60%, and artificial flavors, 40%.

Aroma and flavor chemicals, of which there are 1500 to 1800, are used in a broad range of processed products, which cover almost the entire food and beverage industry, as well as in personal care and tobacco products. Flavors are manufactured using several different technologies by flavor houses—which usually are privately held or subsid-

aries of larger, publicly held companies. Historically, the industry has been self-regulated.

A subclass of compound flavors are reaction or process flavors in which a mixture of ingredients may be heated to produce desired chemical reactions and mimic a flavor. To produce savory flavors such as those found in meat, selected mixtures of proteins, amino acids, fats, and carbohydrates are heated to simulate the cooking process. Similarly, enzymatic reactions are used to reproduce cheese flavors. The recent introduction of surimi, which is based on fish protein, has increased the demand for seafood flavors. Most efforts have focused on extractions of flavors from fish, shellfish, shells, and seaweed.

Unlike the flavor industry, the food color business is a small, highly regulated industry. Producers of food, drug, and cosmetic colors in the U.S. include Crompton & Knowles, PMC, and Warner-Jenkinson. Yet like other additives, marketing trends will be toward the use of natural products, says Harry N. Meggos of Warner-Jenkinson Co. Colors serve both an aesthetic function and as a means of identification, since connections are made between colors and flavors.

Colors fall into two main categories—certified colors, which are synthetic compounds of known structure whose production is regulated by FDA, and exempt colors, which are natural colors derived from animal, vegetable, or mineral sources or their synthetic duplicates. After a period in the 1970s when many colors were banned because of fears of their being unsafe, the number of certified colors has dropped from a high of about 20 in the 1950s to six, explains Meggos—red No. 40, blue No. 1 and 2, green No. 3, and yellow No. 5 and 6.

Sales of food colors are estimated at \$250 million with synthetics accounting for less than \$100 million, says Meggos. In 1990, 8.4 million lb of industrial certified food colors were sold. Growth has been around 1% over the past few years and is expected to continue at that level into the 1990s. Natural colors are expected to show much higher growth as a result of market pressures.

Common colors exempt from certification are often extracts from seeds, roots, and vegetables such as turmeric (yellow), annatto (orange/red), and paprika (red). Although found in plants, a synthetic form of beta carotene (orange/red) is used most often and is exempt. Cochineal, a very expensive red color at \$150 to \$200 per lb, is based on an extract from insects. Already used in cosmetics, it is finding increased use in foods to replace synthetic red colors. Two other frequently used exempt colors are caramel, from burnt carbohydrates, and titanium dioxide, from mineral sources.

A problem with natural colors is their stability, says Meggos, as they are sensitive to pH, light, and heat. With low tinctorial strengths when compared with synthetic colors, 10 to 50 times more of a natural color may be required. Although not all categories of foods may contain colors, he adds, U.S. regulations allow their use in unlimited amounts, but generally less than 100 ppm is needed. But, because these materials come from natural sources, they tend to be higher in price and subject to uncertain supply conditions, making widespread use, while desirable, less likely.

Most other food additive categories are relatively mature and growth rates of only 2 to 3% are expected. One of the slowest growing is the emulsifier market, although it accounts for a large share of food additive sales. The food industry is estimated to use about 250 million lb of surfactants, says Connie M. Hendrickson, director of Arkon Consultants in Dallas. However, surfactants make up one of the smallest percentages of "inactive" ingredients in foods.

Surfactants as food additives act as emulsifiers, defoamers, and wetters in food processing. Generally, nonionic forms are used because they are easier to handle and more predictable to work with than other surfactant types, says Hendrickson. Used to make two phases miscible, emulsifiers stabilize and homogenize processed foods and prevent the formation or aggregation of particles. In preventing sedimentation, they can prolong a product's stability and shelf life. Emulsifying agents

modify texture and rheological properties, and prevent foam formation in processing.

Phosphates as food additives can also act as emulsifiers in dairy and dessert products. About 67 million lb of phosphates were used in the U.S. food industry in 1990. In bakery products such as mixes and doughs, phosphates function as chemical leavening agents. Protein modification and sequestration are this additive's major functions in meats such as ham, luncheon meats, bacon and sausages, and in poultry and seafood. Cheeses, puddings, coffee creamers, and whipped toppings also contain phosphates as protein modifiers and sequestrants. In cola beverages, phosphoric acid is used as an acidulant and flavor enhancer.

Food additives must show demonstrable safety in animal studies and are granted GRAS (generally recognized as safe) status by FDA. Standards of identity also affect many processed foods where regulations control the amount, if any, allowed of certain food additives. Although there are a few very profitable specialty food additives, new products must compete in performance and price with many already satisfactory and approved products. Large R&D investments, along with high costs and long delays in required regulatory approval, can be disincentives and barriers to market entry. "In this environment, it is estimated that fewer than 10 novel chemical entities have received approval by FDA as direct food additives in almost two decades," says Nicolo Bellanca, a senior consultant from SRI International.

"The major influences on the industry," he explains, "include the existing food safety and labeling regulations, the changing likes and dislikes of consumers, and the needs of food processors." Interactions among the needs of these groups shape a number of key issues whose overall impact on the food additives business may vary in intensity and over time. "Most commercial development efforts in food additives appear to focus almost exclusively on the functional areas that offer the potential for regulatory approval of one or two additional products by 1995," says Bellanca. □

Controversy over Indirect Costs of Research Has Universities Squirming

Disclosures that taxpayers' funds have been spent on frills rather than intended research has triggered hearings and investigations in Washington

Pamela S. Zurer, C&EN Washington

In Washington these days there's no escaping the controversy over the indirect costs of research. Revelations that universities have spent taxpayers' funds on frills rather than the research they were meant to support has made the issue a hot political topic.

Congress is holding hearings, conducting investigations, and drafting legislation. The White House Office of Management & Budget is revising its accounting guidelines.

A task force within the Department of Health & Human Services is pondering the issue, while the Department of Defense reviews its policies. University officials and their Washington representatives, meanwhile, are trying to shift the focus from accounting scandals to the need for systematic reform in research funding.

It may take a year or more before the implications for the research community of all this frenetic activity become clear. But even now it's apparent the current methods of dividing the research funding pie between scientists and university administrations are on the way out.

Indirect costs are the monies universities take from re-

search grants and contracts to cover expenses that can't be assigned to a specific project. For example, equipment, materials, and individual research workers' salaries easily can be pegged to a particular grant or grants.

However, other costs such as maintenance, building depreciation, utilities, and salaries of administrators to keep things running are trickier to handle. In the years since World War II, the federal government and research institutions have developed a system to handle those indirect costs.

Briefly, expenses not classified as

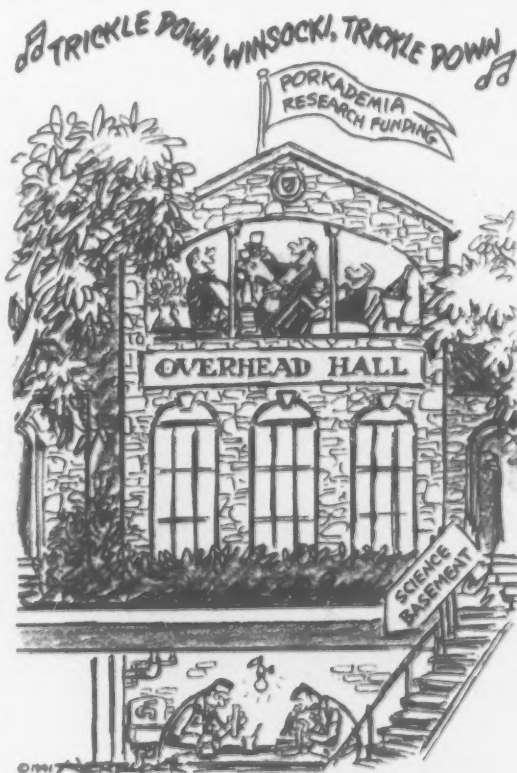
direct charges are allocated to various cost pools—general or departmental administration, library, operation and maintenance, and the like. Then a determination is made as to what percentage of each pool supports research as opposed to other university functions. A weighted average of those percentages, negotiated each year for each university, then is charged against research grants as the indirect-cost recovery rate. It's that system that's now under the microscope.

Scientists, while recognizing indirect costs as a necessary evil, have never liked losing control over a substantial portion of the research funds they bring into the university.

"By and large operating scientists always feel overhead is too high, no matter how low the rate might be," says Paul Gassman, chemistry professor at the University of Minnesota. Gassman, immediate past-president of the American Chemical Society, stresses his opinions are his own and not official ACS policy.

In recent years, as indirect-cost recovery rates have climbed above 60% and 70% at some major universities, the chorus of complaints has grown louder. Sharp protests by Stanford University faculty caught the attention of Rep. John D. Dingell (D-Mich.), forceful chairman of the House Energy & Commerce Committee.

Last fall Dingell asked Congress' General Accounting Office, as well as staff investigators from the Investigations & Oversight Subcommittee he also chairs, to look



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into Stanford's accounting. Also on the hot seat was the Office of Naval Research (ONR), the Defense Department agency with the responsibility for negotiating indirect costs and overseeing federal funds at Stanford.

The results have proved both embarrassing and expensive to Stanford. At a hearing before Dingell in March, Stanford officials lamely tried to explain away mischarges and overcharges throughout the 1980s—including the university yacht, antique furniture, and flowers for the president's house. A GAO auditor claimed they could total as much as \$200 million (C&EN, March 18, page 4).

ONR auditors also came in for scathing criticism from Dingell, who asserted they had been asleep at the switch. In the aftermath, ONR has unilaterally cut Stanford's provisional indirect-cost rate to 50%—a step that could cost the university \$20 million a year (C&EN, May 6, page 26).

Dingell's scrutiny set off an explosion of activity. While GAO and the Dingell committee continue their probes, ONR has asked the Defense Contract Audit Agency to audit all 41 universities whose research funds the Defense Department is responsible for overseeing. HHS, which oversees the majority of research institutions, has announced plans to audit the 20 largest this year. And universities have initiated their own reviews in hopes of heading off uncomfortable revelations.

Nevertheless, titillating tidbits continue to surface. At a second hearing Dingell convened in May, HHS revealed among other items that Dartmouth University had been charging the federal government for its president's chauffeur; Cornell University for chartered aircraft for its president; and the University of Pittsburgh for a trip to the Grand Cayman Islands by its president's wife.

"I believe that universities now understand that this is a new day and that all overhead charges they make to the government must relate to government-funded research rather than merely support a country-club life-style," Dingell said. "Taxpayer dollars must support research—not receptions—and scientists—not sailors."

HHS inspector general Richard P. Kusserow testified he believes the system has evolved so that the scientific raison d'être of indirect cost reimbursement has gotten lost. "It's become a whole other world with accountants playing games on paper," he says.

Kusserow says at least some of the problem stems from OMB Circular A-21, the guidelines on cost accounting at educational institutions, which is so unspecific it encourages constant wrangling. "Unfortunately, the way the system operates it invites gamesmanship. It invites an attitude of 'We [the university] will put as much as we can in the indirect cost pools and you [government auditors] see if you can find it.'"

At HHS, Kusserow, NIH Director Bernadine P. Healy, and HHS assistant secretary for management & budget Kevin P. Moley have formed a working group to examine the costs of research in general and indirect costs in particular.

At OMB, director Richard Darman already has set in motion changes to Circular A-21. "Recent information shows abuses in reimbursements claimed by universities for indirect costs supporting government-funded research. These require additional guidelines to clarify policy and stop the abuse," he said in announcing the first round of changes in April.

The initial proposed revisions (since published in the May 15 *Federal Register*, page 22618) specifically forbid, among other items, reimbursement for entertainment and alcoholic beverages, housing and personal expenses of university officials, country-club and social-club memberships, and salaries above \$120,000 per year.

As NIH director Healy comments, such charges are so obviously remote from research that no one can argue the wisdom of disallowing them. What is surprising is that they have been legal before now.

Most of the abuses that have been revealed in Dingell's hearings are addressed by that first set of proposed OMB revisions, points out Carol Scheman, policy analyst with the Association of American Universities (AAU). Scheman says AAU, which represents major research universities, favors addressing the indirect-cost controversy through changes to existing OMB regulations, as opposed to new laws.

AAU, however, is unhappy with OMB's more recent proposal to cap reimbursement of the administrative parts of indirect costs at 26%. Currently, university administrative overhead rates range from 12 to 45%. Those whose rates now fall under the cap would be reimbursed at the current rate, whereas those with higher rates would get less money.

"This proposal is very inequitable," Scheman says. "It would take a huge chunk out of a very limited number of schools without relieving the paperwork burden. For example, Columbia University would lose \$7

Indirect cost rates vary widely at top R&D universities

	Cognizant agency ^a	Total federal R&D funds ^b (\$ millions)	Indirect cost rate ^c
Stanford U	DOD	\$239.8	72%
Johns Hopkins U ^d	HHS	211.9	65
Massachusetts Institute of Technology	DOD	207.2	58
U of Washington	HHS	203.7	53
U of California, Los Angeles	HHS	170.8	48
U of Michigan	HHS	167.9	59
U of California, San Diego	HHS	166.6	49
U of California, San Francisco	HHS	159.0	38
U of Wisconsin, Madison	HHS	150.5	44
Columbia U	DOD	150.3	74

Notes: DOD is Department of Defense, HHS is Department of Health & Human Services. ^a The cognizant agency for each university is responsible for overseeing R&D funds from all federal agencies. ^b Fiscal 1989. ^c Ratio of indirect costs to direct costs less exclusions. ^d Excludes Applied Physics Laboratory. Source: Department of Health & Human Services.

Indirect cost rates: a confusion of calculations

Testifying before Congress in late April, Rensselaer Polytechnic Institute president Roland W. Schmitt said his institution's current indirect cost recovery rate is 59%—about average for research universities. Yet, he later explained, 72% of Rensselaer's research funds are spent on direct costs such as

salaries, equipment, and supplies. The other 28% goes to overhead expenses not easily attributed to specific research projects.

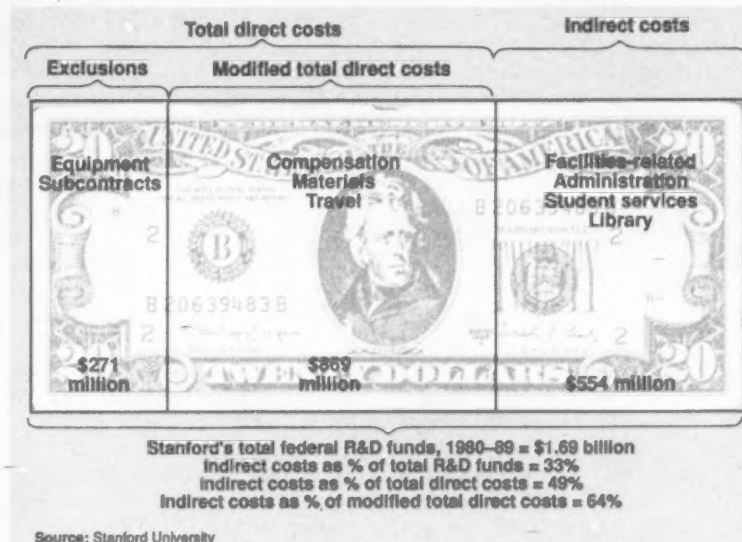
Schmitt was not contradicting himself. Rensselaer can spend just 28% out of each dollar on indirect costs and still have an overhead rate of 59%. For

in the game of academic cost accounting, calculating an indirect cost rate is not as simple as dividing overhead costs by the total amount of research funds.

Rather, the rate is calculated as the ratio of indirect costs to a subset of direct costs. Office of Management & Budget rules require that certain direct expenses be excluded before the rate is computed. Then once the ratio of overhead to modified direct costs is determined, it is used as the recovery rate in future grant proposals and billings.

For example, Stanford University reports it received nearly \$1.7 billion in federal research funds during the 1980s. The university charged \$554 million of those monies, about 33%, as indirect overhead costs. The other \$1.1 billion was charged directly to individual grants.

Out of those direct costs, about \$271 million was spent on equipment and large subcontracts that OMB says must be excluded from the overhead recovery rate calculation. The remaining \$869 million is the modified total direct cost. Dividing the indirect cost by the modified total direct cost yields an overhead rate of 64% for Stanford for the decade as a whole.



million. It costs more to administer research in New York City."

OMB's administrative cap is almost the opposite of what AAU proposed two years ago in its report, "Indirect Costs Associated with Federal Support of Research on University Campuses: Some Suggestions for Change."

The AAU report proposed setting not a cap but a threshold rate on administrative costs, something like the standard deduction for income taxes. Such a threshold would save money by eliminating paperwork, the report reasoned. Under the scheme, universities that chose to document a claim for a higher administrative indirect cost rate could do so.

But not only OMB is proposing to cap certain indirect administrative costs. Two separate House committees have drafted bills that also would place 26% caps on administrative costs. (Ironically, Dingell, who raised the whole issue in the

first place, believes it's too early in the study of the problem to impose legislative solutions.)

The caps are contained in separate bills that reauthorize NIH and the National Science Foundation. The NIH reauthorization bill, as amended by the House Energy & Commerce Subcommittee on Health & the Environment, contains so many controversial provisions in addition to the overhead cap that its fate is dubious. The NSF reauthorization, however, reported to the House for floor action by the Committee on Science, Space & Technology, stands a chance of passage.

While both bills directly address the administrative portions of indirect costs, they do not place caps on a second controversial category—buildings and facilities. Many in the university community believe it is lack of direct federal support for research infrastructure that has driven private universities in particular to try to squeeze as much money out of

indirect costs as they can. The bills, however, do specify that indirect costs paid for depreciation or use allowances may only be used for construction, repair, or renovations of facilities primarily devoted to research.

There will certainly be more changes to come before the dust settles. Although the White House Office of Science & Technology Policy has yet to get into the act, the science committee bill requires OSTP to chime in with a study on which costs can be properly deemed direct and how indirect costs are allocated.

"Everyone would admit there are legitimate costs related to research that can't be identified as direct charges," says John R. Wiesenfeld, Cornell vice president for planning and chairman of ACS's Committee on Chemistry & Public Affairs. "Clearly it's a problem that's got to be solved by government working in cooperation and in harmony with academia." □